Journal of the Society of Arts.

FRIDAY, JANUARY 22, 1858.

PRIZE FINANCIAL ESSAY.

Essays bearing the following mottoes have been received by the Secretary :—

Métal Precieux.
Carpe diem.
X^n.
Virtus sola invicta.
E.C.S.
Counting the Cost.
Debitum Solvendum.
Labore et Fiducia.
Pecuniœ obediunt omnia.
Ubique.
Great is truth, and it prevails.
Publicus.
It is never too late to mend.
Maneant nostros ea fata Nepotes.
Finem respice.
"If thou desirest to know the value of a guinea, go and try to borrow one."
Financier.
When gold speaks, all tongues are silent.
Johannes.
Simplicity is strength.
Euston.
"Theories ruin nations; follies individuals."

EXAMINATIONS.

Drawing (Huddersfield, 1857).

The Council have awarded prizes of books to Wainman Topham, Bradford Mechanics' Institution, and Robert Wilson, Lincoln Mechanics' Institution.

NEW ZEALAND FLAX.

It will be in the recollection of Members that allusion was made in the Chairman's address* at the opening of the present Session, to the offer lately made by the New Zealand Government of prizes for encouraging the production of New Zealand Flax, of which notice had previously been published in the Society's *Journal*.† The following communications in reference to this subject have just been received from the Colonial Secretary in New Zealand :—

Colonial Secretary's Office, Auckland, Sept. 16, 1857.

Sir,—I have the honour to transmit to you the enclosed notices, as in the margin,‡ offering rewards to the amount of £4,000 by the Government of New Zealand, for the discovery of efficient means for rendering the flax and other fibrous plants of New Zealand available as articles of export.

I have also to inform you that a box, the freight of which has been paid, and the bill of lading of which is enclosed, has been forwarded to your address by the *Kenilworth*, containing the samples of flax referred to in the accompanying extracts of letters received from the gentlemen named in the margin,‖ and a further sample from Mr. Wastney,* of Nelson, with respect to which no particular observations have been furnished.

The Government of New Zealand is very anxious that every publicity should be given to its desire to promote, by these rewards, or in such other way as may appear advisable, the profitable exportation of the Phormium Tenax and other fibrous plants of New Zealand, and will be happy to co-operate with the Society of Arts in any manner which the Society may suggest for the attainment of that object.

For further information on this subject I beg to refer you to H. Sewell, Esq.,† a member of the Executive Council of this Colony, now in England, whose present address is given below.

I have the honour to be, Sir,
Your very obedient servant,
E. W. STAFFORD.

The Secretary of the Society of Arts, Adelphi, London.

The following are the notices referred to in the foregoing letter :—

Colonial Secretary's Office, Auckland, December 20th, 1857.

The Government of New Zealand is prepared, subject to the undermentioned conditions, to give rewards to the amount of £4000, for the discovery of efficient means for rendering the flax, and other fibrous plants of New Zealand, available as articles of export, viz. :—

£2000

To the person who shall, by some process of his own invention, first produce from the *Phormium Tenax*, or other fibrous plant indigenous to New Zealand, one hundred tons of merchandise.

£1000

To any person, other than the person entitled to the first reward, who shall, by some process of his own invention, next produce from the *Phormium Tenax*, or other fibrous plant indigenous to New Zealand, one hundred tons of merchandise.

£1000

Viz. :—£200 to each of the first five persons, other than those entitled to the first and second rewards, who shall by any process, whether of his own invention or not, produce from the *Phormium Tenax*, or other fibrous plant indigenous to New Zealand, twenty-five tons of merchandize.

The merchandize must be saleable as an article of export from the colony of New Zealand, and have been produced at a cost not exceeding 75 per cent. of its value at the port of entry from which it is exported; and the process must be fully made known with a view to the discovery being at once made available to the public.

His Excellency the Governor of New Zealand will from time to time appoint commissions, to consist of not less than three persons, to act at such places as circumstances may require, and each claim for reward will be referred to such commission as may be considered the most convenient for its proper investigation. The acts of the majority will be deemed the acts of the commission.

Each commission shall be at liberty to adopt such means as it may deem most fit for determining the value and cost of production of the merchandise, for ascertaining the process employed, and for fully investigating in all respects, and reporting upon the validity of any claim.

Every claim for reward must be preferred in writing, before the 1st January, 1859, to the principal officer of Customs at the port of entry nearest to the place where it is desired that the examination of the merchandise shall take place, who will at once proceed to ascertain whether the full quantity, in respect of which the reward is claimed, is ready for examination, and if such quantity is ready, he will give a certificate to that effect, dated on

* See *Journal*, Vol. VI., p. 3.
† See *Journal*, Vol. V., p. 328.
‡ See next col.
‖ Rev. Jas. Preece, Baron de Thierry, Mr. M. Whytlaw.

* In error marked on the specimen as Mr. M'Glashan.
† H. Sewell, Esq., care of the Rev. Wm. Elwyn, Worsley Vicarage, Caxton, Cambridgeshire.

the day on which he shall have ascertained the fact, and such day shall be deemed to be the day on which the merchandise was produced.

Whenever any officer of Customs is required to go more than three miles from his residence, his travelling expenses must be paid beforehand by the person requiring his attendance, and he cannot be required to attend a second time if the quantity was found deficient on the first occasion.

One-half of any reward will be paid at once to any person whom a commission shall report, and the Governor shall have determined, to be entitled to the same—after which no other claim to the same reward will be entertained—and the other half upon satisfactory proof being given to the Governor of the *boná fide* sale of the merchandise in Europe, at an advance of not less than 20 per cent. upon the *boná fide* actual cost of the article landed in Europe.

By His Excellency's command,
E. W. STAFFORD.

Colonial Secretary's Office, Auckland, June 10th, 1857.

With reference to a notice dated December 20th, 1856, published in the *Government Gazette*, No. 43, of the 24th of December, 1856, offering, on certain conditions, rewards to the amount of £4,000 for the discovery of efficient means for rendering the flax, and other fibrous plants of New Zealand, available as articles of export, it is hereby notified, with respect to the first and second rewards of £2,000 and £1,000 respectively, that, although the whole quantity of 100 tons must be produced to entitle any claimant to the reward, an examination of the merchandise will take place, if desired, whenever 20 tons are ready for inspection, and will in like manner be repeated on any further separate quantities of not less than 20 tons each, until the whole amqunt of 100 tons is made up.

With respect to the third reward of £1,000, an examination will take place whenever five tons are ready for inspection, until the whole quantity of 25 tons is made up.

E. W. STAFFORD.

The following are the extracts referred to in the foregoing letter :—

EXTRACT FROM LETTER OF THE REV. JAMES PREECE, STAPLETON, COROMANDEL, DATED FEB. 28TH, 1857.

"I hasten, therefore, to forward to you the required specimens of prepared flax as you requested. Each number is prepared from a different variety. I have numbered them 1 to 5. The whole of the samples are very far inferior to what they would have been had they been properly cultivated; but the natives have let the plants grow wild for nearly twenty years; the plants have therefore greatly degenerated for want of culture; therefore, the colour of the flax is not so white; the fibre is also very much coarser, and not so strong as it otherwise would have been. The natives have left off the cultivation of the best flax plants for some years past (except in the interior of the Bay of Plenty, where a small quantity is still cultivated for the purpose of producing flax to make their own garments). All the flax that is sent to market is procured from the swamp variety, which is fit for making coarse canvas and rope. But all the varieties now forwarded would, if properly cultivated, be available for the purpose of manufacture, from coarse linen to fine cambric, or even some, as No. 5, to work up with silk. Nos. 4 and 5 would be very fine and white if proper attention was paid to its cultivation, as may be seen from No. 5a; that sample was from a plant that had been cultivated a little, but was not prepared with care, (it having been done by children, nearly a year ago; the bark was not properly taken off, therefore the one end is stained) yet, I thought, that it would be well to send it, because it will show the difference between the flax from cultivated plant and that of the same sort when uncultivated, although it has been both indifferently cultivated and prepared. After twenty six years' observation and attention, both to the plants and their culture, I am fully convinced that these varieties, if carefully collected and cultivated, would yield a flax far superior to that produced in any other country, and would give the most profitable export that this colony will ever produce. All the best varieties are only to be found in small quantities scattered over the country, and will, I fear, soon nearly disappear. I would, therefore, beg leave to suggest that the best and only way to secure such an invaluable article of export to this colony, would be to select a duly competent person, who is thoroughly conversant both with the plants of each variety and their mode of culture. He should be supplied with a sufficient sum of money to enable him to collect and plant a field to contain not less than ten acres; he should find the land and continue to cultivate the plants for a certain term of years, constantly giving all needful information to the public as to the best modes of culture, &c.; he should also make every exertion in his power to increase the number of plants of each variety, both from seed and roots, so that he may be able to supply the public gratis, upon producing an order from the general government.

"I am also of opinion that it would be desirable to plant an acre or two of the native cotton plant, so as to give it a trial and ascertain its real value. I am not certain about its value; the quality I believe to be good, but whether the quantity would be sufficient to remunerate both the labour of cultivation and preparation for market, I am not certain, but with respect to the flax, I am confident that the result would be quite satisfactory. No time should be lost; the field should be planted before the ensuing spring. I shall at all times be happy to supply the Government with any information on the subject, or in any other way forward their wishes on that subject."

BARON DE THIERRY'S OBSERVATIONS ACCOMPANYING SAMPLES OF FLAX.

For upwards of eighteen years I have been employed in preparing the *Phormium Tenax*, and about fifteen years ago I discovered the *Ti*, the name of which is pronounced after the Italian sound of the letter *i*.

The Phormium Tenax.

The great delicacy of the fibre of native flax (as this flax is generally called) impressed me with a belief, which many trials confirmed, that no method could be thoroughly available except such as would offer the least resistance to the fibre, and bring into use the whole length of the leaf, nor was I mistaken.

It takes about six tons of green leaf to make a ton of flax, and the waste of any available portion of the leaf must be a loss which political economists would wish to guard against, and which flax makers cannot afford.

Like other experiments I tried boiling, but it did not soften the leaf very materially; after a few boilings, an iron pot turned the flax black, and a copper or bell metal pot turned it green. The use of an alkali discoloured the flax and weakened the fibre, and the expenditure of a penny upon a pound of flax would be nearly half its market worth, and would, on a large scale, be a very serious expenditure. Flax must be made cheap or must be let alone. I tried steam, and my triumph was complete; the leaf became perfectly soft, like a well boiled asparagus. With a mill, resembling a fulling mill, I beat out the fleshy part of the leaf rapidly and efficiently, without the slightest injury to the fibre. My means were so limited that I had to study every sort of economy. For steaming chests, I substituted two tun butts; my furnace, owing to the lowness of the roof, had to be sunk underground, and would not draw except with a westerly wind; then there was no water to work the water wheel, yet, on the first day of trial, with only seven beaters, and with children who had never been in a factory before, I

made at the rate of 120 lbs. of converted flax per hour, the flax being weighed after being washed and dried. But the casks were of oak, and a stage was raised about a foot and a half in the interior with billets of firewood, to keep the leaves from touching the water distilled in the process of steaming. With sufficient steam for steaming, and with sufficient water for the water wheel, I could have made flax for sale at £15 per ton at a large profit. The colouring matter of the oak and firewood coloured the flax, as may be seen by No. 5, and yet so superficial was the colouring, that by my cleansing process, which I term the "secondary process," I have, with no other agency than water, brought the same flax to what it is in No. 3—which merchants of Auckland say is the best flax ever produced in this market. I found, too, that the deep red of the lower end of the leaves, if cut down to the bulb, yielded a colouring matter which diffused through the flax by the steam, as is shown in No. 4. To guard against these things, it is only requisite to construct the steam chambers of white wood, and to cut the leaves about a foot above the bulb; the steamed flax will be of a pale green, and after cleansing will be quite white. The efficiency of my method of applying the secondary (water) process, may be seen by No. 2. No. 1 was flax of the finest *Tihore* kind, scraped, by desire of the resident missionary at Coromandel, by natives; it smells sickly, and gradually grows darker by keeping, as the gum, which nourishes the fibre when growing, and is its bane when cut—discolours and corrodes it. No. 2 is the same flax, having undergone my cleansing or depurating process, without any other agent than water; the fibres are separating, and every day it becomes whiter and finer, because the gum is no longer there. The gummy flax is hard, and springs after being compressed, whilst the gumless flax retains the form given it without springing, and can be compressed into nearly half the bulk. All steamed flax will bear the sea without heating or becoming musty, because what portion of gum remains becomes inactive, but the gumless flax is by far the most valuable as an export, because it is ready for immediate use, and can, by heckling, be brought, without new machinery and without chemicals, to any degree of fineness.

A very erroneous impression exists about the native flax. It has been represented as stronger than European hemp, but it is not so. Whilst the strands of fibres are held together by the gum, in a yet fresh state, the strength of these strands, collected together into a rope, is amazing. By age and exposure it becomes acrid, and corrodes the fibre, and renders the rope weak and brittle, as is proved by the native baskets or kits, which are of great strength when fresh, and break to pieces when dry and old. So powerful is the effect of the gum upon the fibres, that in a few days after being cut, the leaf rolls up like a rod, and becomes brittle as straw, scarcely any trace of fibre remaining when quite dry.

To reduce the amount of labour as much as possible, rather than to seek a better method, I have dispensed with beating. I find that with rollers, of my own construction, I can turn out more flax at less cost. I have, by renewed exertions, arrived at three important results, the production of a first-rate merchandise, at the low price of £14 per ton (including purchase of leaves), rapidity of production, and freedom from gum. Flax which will not deteriorate under ordinary circumstances, which will not heat, and which requires no additional expense to be made available to the European consumer.

Without dwelling upon idle wranglings about the relative strength of European and New Zealand flax, it must be obvious that as a far greater quantity of *Phormium Tenax* could be grown in New Zealand than cotton in the United States, a most important fact presents itself,—the fact that as flax may be made gumless, and may be applied to a multitude of fresh uses, it is well calculated to develope new means of wealth to the mother country. When flax shall be cultivated, the finer sorts need cost no more in New Zealand than the coarser, and though all kinds are valuable, and though all can be made at a large profit, the largest return will be realised by the finest quality. In the event of a war with cotton-producing countries, Great Britain might be materially relieved by this hitherto costly colony. Inspection of the gumless flax will satisfy any experienced person of its adaptability to making excellent linen, and to be woven with cotton or wool into a valuable union cloth.

Although the appearance of No. 2 is so much brighter than No. 3, the close observer will find that, allowing something for the difference in the quality of the plant, the fibre of No. 3 is very little inferior to No. 2. When worked up, there will be but a trifling difference, which shows that, with similar leaves, a superior result to the native scraped will be obtained by steaming, a result the more evident, as everyone must see that No. 2 is superior to No. 1, and that I greatly improve the market and physical condition of the native scraped. The natives cannot make flax to remain unchanged or white, however much they may wash and pound it. In proof of this, I need but call attention to the finest mats they make, which are never whiter than straw-colour, and always darken with age.

The Ti.

The flax from the *Ti* is my own discovery, and I believe that competent judges in Europe will bear me out in the assertion that it is finer and stronger than the *Phormium tenax*. The sample which I send was simply beat out and washed, and the accompanying specimen of the same material, prepared *chemically* by one of our townsmen, will show how exquisitely fine the fibres will separate. I never resort to chemicals, nor do I wish to employ them, for they must always prove expensive. This flax (such as my own sample) could be sold at about £12 per ton, whilst Mr. Hornby assures me he could not make his for less than £40. The question is, of course, which would be the most remunerative? When chemicals *must* be used, I would be in favour of sending the fibre to England in its raw stage. The very plea of economy would induce me to advocate the prudence of ridding the *Phormium tenax* of its gum before shipment from this country. Water is as cheap in New Zealand as in Europe, and as water alone is needed in my cleansing (or secondary process), and as little manual labour is required, which little is fully balanced by the reduced bulk and lessened freight, I could see no reason for sending an unsound perishable material to Europe, when a sound and improving staple can be furnished at the same cost. I believe the *Ti* will be found applicable to the finest textures, from lace downwards.

The *Ti* is a tree which grows as high as 20 to 30 feet, and the flax is the product of the leaves, which are about three feet long, and from $\frac{3}{4}$ths of an inch to an inch wide. The whole tree is of a stringy nature. It is very hardy, and cuttings upwards of 6 inches in diameter will take root in moist land. It grows in swamps where nothing else will stand; it makes an impenetrable live fence; it grows either in or out of water, and prospers upon the highest hill and in the deepest gully.

I avail myself of this unexpected opportunity to express an opinion that the rule of the government, not to interfere with private enterprise, might be with great advantage departed from as relates to the *Phormium tenax* and *Ti*. Governor Fitzroy made a most praiseworthy attempt at manufacturing woollens, and it is much to be deplored that he did not persevere. A Governor clad in homespun would have been a glorious event for a young colony like this. Nothing would work out the great problem of the civilization and humanising of the native race so effectually as working upon their ruling passion, and proving to them the large profit to be derived from the manufacture, by a rapid process, of the flaxes which abound in their country. A

powerful flax mill, established by the Government, in which natives would be received and taught the easily-acquired art of flax making, would induce them to introduce that industry into their many fine flour mills, and would diffuse wealth throughout a land so depressed as this at the present time.

I say nothing of the medicinal properties of the *Phormium tenax*, as they have to be tested in a regular way. The natives make much use of it for their horses and for themselves. The gum may be the chemical agent, but of neither the gum nor the juices can I say more than that there is every reason to believe they will be found very valuable. I can save both, and it appears to me that the inquiry would be well worth the attention of Government.

The *Government Gazette* of December 24, 1856, contains an offer of £4,000 as rewards for discoveries in flax-making. I must take the liberty to observe that the Auckland Chamber of Commerce did not, in my humble opinion, give the subject the wide scope which it seemed to demand. I think more justice and more good service would have been done if a single reward of £2,000 had been offered, and that a reward had been held out to persons planting a certain quantity of flax and *Ti*. Large plantations would necessitate flax-making, and would stamp the value of the export. I think, too, that discoverers should be rewarded without reference to manufacturing, as the one should be separate from the other. I mean, of course, those persons who should discover new fibres capable of giving increased wealth to the colony. The discoverer of an available gold field would not be compelled to be a digger in order to earn his reward. I think, moreover, that instead of the minor rewards, it would have been better to promise a bounty of £5 per ton upon the 200 tons shipped under the published reservations; it would have been more likely to spur the poor man as well as the rich one to exertion.

I would wish to see the opening of a scientific Commission, under the immediate observation of the Governor, into the different modes of making flax; into the cause of the failures which have been so fatal to the best interests of the colony; into the most promising and available system of making flax, and into the advantages to be derived by each system by the home and colonial interests. Witnesses to be examined separately and upon oath. And I would gladly see the result become the basis of prospective reward, the Government, or rather the Government Commission, declaring the name of the most successful candidate, or the candidate to whose plan it might appear that most confidence might be given, but in forming a commission I would scrupulously avoid appointing any member who could be suspected of bias—none but flax-makers to be examined, in order that a practical result should be obtained.

I trust I shall be forgiven the perhaps unreasonable length of this paper—a subject of such vital importance should not be treated with levity. The worth of many millions sterling surrounds us, and as we may some day be called upon to meet extraordinary demands and expenses for which we are ill prepared, we must look upon the development of the resources of the country as a state question, sanctioning the deepest and most patient inquiry. (Signed) THIERRY.

Auckland, Feb. 17, 1857.

EXTRACT FROM LETTER OF MR. M. WHYTLAW, DATED 11TH MARCH, 1857.

"In compliance with the request which you have done me the honour to make, I have forwarded herewith three samples of our manufacture. No. 1 is the best quality we have as yet prepared, No. 2 is that of our ordinary manufacture, and No. 3 is an article which we think may suit the purposes of the paper-makers well.

"The method of preparing the native flax for the market which our firm has adopted is one which I invented several years ago; and I believe it differs from all others that have heretofore been attempted in this respect, that the fibre is separated from the leaf of the plant by a transverse action upon it, and not a longitudinal one, in imitation of the natives' method of manipulation, which so many have tried to do unsuccessfully by machinery. The whole process at our works is exceedingly simple. The flax is merely cut from the plant, passed through the machine, washed and dried. The washing is not an essential part of the process, but it serves to bring the fibre more speedily to a proper colour when exposed to the air.

"Our factory consists of a large iron building, of two floors. We have a steam engine of 15 horse-power and thirty-two machines, each of them capable, when in full operation, of producing fully 100 lbs. of prepared flax per day. Each machine requires the attendance of only one boy. Other boys are employed in cutting, washing, and bringing the flax out to dry. Hitherto we have only had a small number of the machines in use, but we are gradually extending our operations, and hope in a few months hence to produce a very satisfactory quantity per day. At present we obtain our supplies of the raw material from the natural produce of the neighbourhood, but we are preparing to cultivate the best sorts in the vicinity of our works.

"As such a business is doubtless one of Colonial importance, and promises, if entered upon energetically by capitalists, to supply what is obviously a desideratum, especially in this Northern Province, namely, a profitable export, I shall be most happy to give all the information on the subject I may be possessed of, to any parties intending to engage in it, and to show our works to any members of the Government who may honour me with a visit, or to any Commissioners who may be appointed to inquire into this important branch of our Colonial resources."

The specimens mentioned have been received, and may be inspected by members and their friends at the Society's house.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JAN. 20, 1858.

The Seventh Ordinary Meeting of the One Hundred and Fourth Session, was held on Wednesday, the 20th inst., Sir John Rennie, F.R.S., in the chair.

The following Candidates were balloted for and duly elected members of the Society:—

Goodchild, John James | King, T.
M'Donald, James.

The following Institutions have been taken into Union since the last announcement:—

451. Ebbw Vale Literary and Scientific Institution.
452. Neath Mechanics' Institution.

The Paper read was:—

ON THE MANUFACTURE OF PUDDLED OR WROUGHT STEEL, WITH AN ACCOUNT OF SOME OF THE USES TO WHICH IT HAS BEEN APPLIED.

BY WILLIAM CLAY, OF THE MERSEY STEEL AND IRON WORKS, LIVERPOOL.

In the paper which I am now about to submit to your notice, I have endeavoured to treat of this comparatively new process, viz., the manufacture of puddled or wrought steel, with an account of some of the uses to

which it has been applied, only in a mechanical and practical point of view, and to avoid entirely any questions as to the chemical change which takes place in the conversion of the crude cast iron into steel; and I have also endeavoured to avoid instituting any comparisons between this process and any others which seek the same result, viz., the manufacture of cheap steel.

It will be well known to many interested in the manufacture of metals, and more especially to any who may have lately had occasion to visit the continent of Europe, that the manufacture of puddled steel has now been practised there for many years, and that the make is rapidly increasing, but, as yet, the uses to which this material has been put are very limited when compared with the vast advantages which would be derived from adopting so strong and durable a material, when produced at a moderate cost.

The process I am about to describe, was patented in the year 1850, by Mr. Ewald Riepe, and it may be asked how it comes to pass that so valuable a patent has been allowed to remain almost entirely unknown in this country, when it was granted so long ago as 1850. One reason is the bad state of health of the patentee, who has seldom been able to devote more than a few days, at any one time, to the subject in this country, without becoming so ill as to be incapacitated from attending to business again for a considerable time. Another reason (as I am informed) is that the patentee, about the date of the patent, came over here and entered into working arrangements with one of the most important firms in this country, viz., the Lowmoor Iron Company, who have, up to this time, made about 1,000 tons of the puddled steel, but who have not, I believe, carried the manufacture of it beyond the puddling process, but have sold the puddled bars to various Sheffield houses for them to carry into the further stages of manufacture, and more especially to Messrs. Naylor, Vickers, and Co., of that town, who have used this material very largely for the manufacture of their cast steel bells, which, I may mention by the way, are also the subject of another patent by the same inventor.

In describing the process of making the puddled steel, I cannot do better than read an extract from the specification of the patentee :—

Riepe's Patent.—" These improvements consist—Firstly, In a peculiar method of working in the puddling furnace. Secondly, In converting pig-iron, or alloys of pig-iron and wrought-iron, into steel, with the co-operation of clay in the furnace. Thirdly, In or by the co-operation of atmospheric air.

" Firstly. I employ the puddling furnace in the same way as for making wrought-iron. I introduce a charge of about 280 lbs. of pig-iron, and raise the temperature to redness. As soon as the metal begins to fuse and trickle down in a fluid state, the damper is to be partially closed in order to temper the heat. From 12 to 16 shovelfuls of iron cinder discharged from the rolls or squeezing machine are added, and the whole is to be uniformly melted down. The mass is then to be puddled with the addition of a little black oxide of manganese, common salt, and dry clay, previously ground together. After this mixture has acted for some minutes, the damper is to be fully opened, when about forty pounds of pig-iron are to be put into the furnace, near the fire bridge, upon elevated beds of cinder prepared for that purpose. When this pig-iron begins to trickle down, and the mass on the bottom of the furnace begins to boil and throw out from the surface the well-known blue jets of flame, the said pig-iron is raked into the boiling mass, and the whole is then well mixed together. The mass soon begins to swell up, and the small grains begin to form in it and break through the melted cinder on the surface. As soon as these grains appear, the damper is to be three-quarters shut, and the process closely inspected while the mass is being puddled to and fro beneath the covering layer of cinder. During the whole of this process the heat should not be raised above cherry redness, or the welding heat of shear steel. The blue jets of flame gradually disappear, while the formation of grains continues, which grains very soon begin to fuse together, so that the mass becomes waxy, and has the above mentioned cherry redness. If these precautions are not observed, the mass would pass more or less into iron, and no uniform steel product could be obtained. As soon as the mass is finished so far, the fire is stirred to keep the necessary heat for the succeeding operation—the damper is to be entirely shut, and part of the mass is collected into a ball, the remainder always being kept covered with cinder slack. This ball is brought under the hammer, and then worked into bars. The same process is continued until the whole is worked into bars. When I use pig-iron made from sparry iron ore, or mixtures of it with other pig-iron, I add only about 20 lbs. of the former pig-iron at the later period of the process, instead of about 40 lbs. When I employ Welsh or pig-iron of that description, I throw 10 lbs. of best plastic clay, in a dry granulated state, before the beginning of the process, on the bottom of the furnace. I add at the later period of the process, about 40 lbs. of pig-iron as before described, but strew over it clay in the same proportion as just mentioned.

" I do not claim the commencement of the above described process for making steel in the puddling furnace. But what I claim is the regulating the heat in the finishing process, and excluding the atmospheric air from the mass in the manner as described, and also the use or addition of iron to the mass towards the later part of the process."

The remainder of the specification it will not be necessary to allude to.

The balls, instead of being rolled into bars, may be hammered into slabs or blooms, for such uses as forgings, rails, plates, or any hammered or rolled steel which requires to be perfectly solid; but for ordinary use, puddled bars are made, at the Mersey Iron Works, from two to 14 inches wide, which are afterwards cut up and piled for various purposes.

In using the puddled bar steel, it has been found very desirable to test each bar before using it, and to closely inspect the quality, and to select such as is best adapted to the purposes required, for instance, for steel rails, or railway points, or switches, which I roll at one operation direct to the regular taper-form desired, under a patent which I have "for rolling iron or other metals of taper form." I select the most crystalline steel for the upper and under surface of the rail or switch, and for the interior that which is of a more fibrous and tougher description. Between the centre and top and bottom of the rail, I place steel of an intermediate grade, which causes the whole pile or mass to weld up easily and work solid.

It is necessary in this, as in any operation in which steel is used, to take the greatest possible care in the heating and working of the material; but from the first commencement there has been found no difficulty in heating, rolling, or forging this steel into any form or shape, as it has been made into steel plates, bars, angle steel, rivet steel, rails, railway points, and forgings of all kinds with perfect ease and with success, and ever since the manufacture was commenced at the Mersey Steel and Iron Works, this steel has been used for almost everything that was required to be of a strong and durable nature or to repair any of those breakages which are of such constant occurrence in every iron work.

It is somewhat worthy of remark that, although this process is so novel, and, apparently, of so delicate a nature, yet, with the specification as my only guide, having never before heard of or seen the operation, it succeeded perfectly in the first trial which was made, and produced so excellent a steel that, after working about 100 tons, it has hardly been surpassed. I have used pig iron of all descriptions, North Welsh, South Welsh, Staffordshire, and Scotch, with the same result, viz., the production of

an excellent steel; but I have not found, so far, anything like the great difference that I expected between hot and cold blast iron. Most excellent results have been obtained from both; this is more particularly important as it shows that the extent to which this manufacture may be carried need not be circumscribed by the very limited supply of cold-blast pig iron.

Having thus described the process of manufacture, it will be necessary to show a few of the qualities of the material produced.

The puddled-steel bar when broken shows a clear crystalline and even fracture, and has the usual sonorous musical tone when struck. The crystals appear much finer and more regular than in ordinary blister steel, in fact, to the unpractised eye, the appearance is quite like that of the best cast steel, and it has all these distinguishing features by which steel is known from iron. It hardens to any degree that may be requisite, taking all the colours which develope themselves under the different degrees of heat, and may be made into such articles as ordinary chisels direct from the puddled bar; it will take a very fine polish, and has the same amount of elasticity that steel usually possesses.

In fact, I believe it to be useful in the Arts for all purposes for which steel is required, except, perhaps, for the finer descriptions of tools and cutlery.

One extraordinary feature in regard to this wrought steel is, that it can be produced either of a harsh, hard unyielding character, or of a soft silky fibrous structure, or of any of the grades between these two points, and that a bar when quite cold may be bent up double and perfectly close (with extreme difficulty certainly on account of the great stiffness of the material) without the slightest sign of fracture, but, when forced back again, a beautiful long silky fibre is apparent; or if a piece of steel plate be partly cut through with a chisel and then broken, it appears beautifully fibrous; if made into a tool, for instance, and hardened, it at once assumes the crystalline character peculiar to steel.

In a series of experiments with regard to the improvements and deterioration which result from oft-repeated heating and laminating of bar-iron, (undertaken when writing a paper on "The Forging of Wrought Iron in Large Masses," for a work entitled "The Useful Metals and their Alloys," and detailed at page 318 of that work), I found "that taking a quantity of ordinary fibrous puddled iron, and reserving samples marked No. 1, we piled a portion five high, heated and rolled the remainder into bars marked No. 2; again reserving two samples from the centres of these bars, the remainder were piled as before, and so continued until a portion of the iron had undergone twelve workings.

"The following Table A shows the tensile strain which each number bore:—

No.		lbs.
1.	Puddled bar	43,904
2.	Re-heated	52 864
3.	,,	59,585
4.	,,	59,585
5.	,,	57,344
6.	,,	61,824
7.	,,	59,585
8.	,,	57,344
9.	,,	57,344
10.	,,	54,104
11.	,,	51,968
12.	,,	43,904

"It will thus be seen that the quality of the iron increased up to No. 6 (the slight difference of No. 5 may perhaps be attributed to the sample being slightly defective), and that from No. 6 the descent was in a similar ratio to the previous increase."

In a somewhat similar series of experiments undertaken with this steel, it appears that, after the first piling, when the bars become solid, a deterioration in respect to tensile strength takes place, which is slow and gradual, but in a regularly increasing degree, as will be found by the following Table B:—

No. 1	Puddled steel	bar bore	96,911	lbs. per sq. inch.
2	Piled	,,	121,408	,,
3	,,	,,	111,608	,,
4	,,	,,	121,408	,,
5	,,	,,	111,608	,,
6	,,	,,	111,608	,,
7	,,	,,	91,136	,,
8	,,	,,	91,136	,,
9	,,	,,	91,136	,,
10	,,	,,	91,136	,,

MEM.—The weight increased 20 cwt. at a time.

The steel used for these trials was what chanced to be at hand, and was not particularly remarkable for any extraordinary degree of strength. The appearance of the fracture of the sample bars, when broken by the hammer in the usual manner, presents to the eye a very slight difference, the colour and size of the crystals being, to all appearance, much the same in No. 2 as in No. 10; but when torn asunder by a machine for the purpose, a very marked difference is observable, the higher numbers having a very fibrous silky fracture; and yet the characteristics of steel are perfectly preserved, for No. 10 hardens, takes the usual colours, in fact, possesses all the distinguishing properties of steel.

I would wish especially to call attention to this steel as a material for large forgings and for ordnance purposes.

It is generally understood in this country that cast-steel has been, to a certain extent, a failure for such uses, and that it has been found that, unless a considerable amount of hammering or rolling be applied to the cast-steel material subsequently to the founding process, that the strength of such cast-steel material is very inferior to that where it has been consolidated by the action of the hammer or the rolls, and that it is not at all suitable where sudden strains are inevitable.

Mallet, in his valuable work on "The Construction of Artillery," argues that cast steel is not suited for ordnance on account of its deficiency in point of elasticity when compared with wrought iron or gun metal.

I imagine that this want of elasticity may be partially accounted for in this manner, viz.—Cast-steel requires a very high temperature to render it fluid for founding, which necessarily causes a considerable amount of shrinking in the casting when passing from the fluid to the solid state, and the casting is of that peculiar crystalline structure which is produced under such conditions (weakened to a great extent also by the strain caused by shrinkage), unless the steel casting is afterwards subjected to the hammering or rolling process before mentioned, by which the particles of steel are relieved from their shrinking strain, and are consolidated and allowed to assume a comparative state of repose.

In the manufacture of forgings from puddled steel, the case is very different. We possess, in the best puddled steel, as great, if not a greater amount of strength, as in cast-steel under the most favourable circumstances, and as the particles of wrought or puddled steel are never in a state of fusion from the time of their first formation in the puddling furnace, the enormous contractile strain incident upon the transition of the steel from the fluid to the solid state, is avoided in the first place, and also the grain of the puddled steel may be so placed in the forging to be made, as the strain which it will be called upon to resist may require, and the different descriptions of steel, whether crystalline or fibrous, may be arranged in the best positions as regards strength and durability. Take, for instance, a large gun forging; the interior may be made of hard crystalline steel, to resist the enormous wear and tear, and the exterior of a softer and more fibrous description, as above described, a result evidently impossible with cast steel, which must necessarily be homogeneous, and be either entirely hard or entirely soft.

It would not surprise me if, with more experience of this new manufacture, it should be found that wrought steel bears the same relative position with regard to cast steel that wrought iron does to cast iron.

There has of late been a considerable controversy respecting an alleged deterioration of wrought iron, when being made into large forgings, from a supposed crystallization of the material employed. I have always endeavoured to maintain, and in my work already referred to I have attempted to show, that where this crystallization took place it was purely the result of carelessness or incompetence.

With wrought steel, the danger from this cause is very materially lessened, indeed, rendered almost impossible, for the heat at which it welds is much less than that required to weld iron, as also if the steel be heated too much (and long before any deterioration from crystallization could set in) the forging when brought to the hammer would be so tender that it would fall in pieces, and would in that manner be wasted for the purpose required; there is, therefore, little fear that crystallization, otherwise bad workmanship, can materially injure this tell-tale production.

Steel forgings have been made, at the Mersey Steel and Iron Works into piston rods, (some with the piston forged solid, 18 inches diam., for a Nasmyth hammer), large roll screws, shear pins of all sorts, rolls for rolling iron, hammers and anvils, and for a variety of other purposes. In making these forgings no difficulty was experienced; rather more time was required on account of the necessity of heating the steel slowly, and also because the hammer did not make the same impression on it that it does upon iron.

The effect of forging upon this steel is to consolidate it, and when broken in the usual manner, the appearance of the crystals is much finer than when it is rolled, as might be expected.

Of all the various uses to which this steel may be applied, there are perhaps none so important as its application to marine and railway purposes; for the former use, the material offers directly so considerable a saving in regard to weight, with an equal amount of strength, (putting out of the question its durability and other advantages) that its universal adoption can hardly be doubted. A commencement has been made by the Board of Admiralty, who have used considerable quantities of Howell's homogeneous metal in the manufacture of marine steam boilers, as stated in the *Times* newspaper of July 6th, which says, "In consequence of the successful trials which have been made at Woolwich, of Messrs. Shortridge, Howell, and Jessop's homogeneous metal, government have given directions for the use of that metal in the construction of steam boilers, one of which is ordered to be made for the 17 gun steam-sloop *Malacca*, Captain Arthur Farquhar."

For railway purposes it is nothing new to propose steel for rails, points, and crossings, &c., as the attention of engineers has long been directed to it, both in this country and abroad, but the difficulty has hitherto been the cost of steel for such purposes. Some attempts have been made to harden the face of rails, and to steel the working parts of tyres, but, I believe, the result has not been altogether satisfactory, and the cost considerable; but with wrought-steel the tyres, points, or rails, may be made altogether of hard crystalline steel, or an outer surface of hard and an inner portion of fibrous steel, as required, and at a cost very materially less than that at which steel has hitherto been produced.

With regard to the ultimate resistance to tension of steel as compared with iron, we find by the tables recently published in the reports of experiments on the strength and other properties of metal for cannon made by officers of the United States Ordnance Department, that the strength of various descriptions of English, American, and Russian wrought-iron, tested by them, varied from 53,903 lbs. to 62,644 lbs. per square inch.

The ultimate cohesion of tilted cast steel bars, as published in Table No. 9 of Mallet's work on the construction of artillery, is stated at 142,222 as the highest, with 88,657 as the mean per square inch.

Other estimates of the ultimate cohesion of steel give,

Tempered cast steel at	150,000 lbs.
Cast steel	134,256 ,,
Shear steel	124,400 ,,
Blister steel	133,152 ,,

With wrought-steel I have also found considerable variation in regard to tensile strength, more particularly when experimenting, as it is necessary constantly to do in a new manufacture, with various descriptions of pig-iron and different charges. But when working regularly I have found no more difficulty in obtaining an uniform result than in the manufacture of iron, and with more experience we may safely expect some improvement even in this particular.

The first bar that was tested broke at 173,817 lbs. per square inch. This extraordinary endurance I have not since equalled, the nearest approach to it being 160,832 lbs. per square inch.

The average tensile strength of the steel, however, may be estimated at about 50 tons per square inch, or 112,000 lbs.

Of four samples tested at the Liverpool Corporation chain-proving machine, on the 8th January, 1858, the first bar, which was made as hard as fire and water could render it, broke at something less than 112,000 lbs., but the exact weight was not ascertained. (This trial bar was from the same steel as No. 3, which, as will be seen, bore the heaviest test in its natural state.) Test bar No. 2 broke at 112,000 lbs., or 50 tons per square inch. No. 3 broke at 125,440, or 56 tons per square inch. No. 4 broke at 98,560 lbs., or 44 tons per square inch.

Mem.—This last sample had a slight flaw, which probably caused the difference.

TABLE C.—*Tensile strength of Iron and Steel Bars per square inch.*

Descriptions of Iron and Steel.	Tensile strength.	Authority.
Russian Iron	62,644	American Board of Ordnance.
English Rolled Iron	56,532	
Lowmoor ,, ...	56,103	
American hammered......	53,913	
Krupp's Cast Steel, average of 3 samples	111,707	Minister of War, Berlin.
Cast Steel, highest	142,222	Mallet.
,, mean	88,657	Ditto.
,, ,, ...	134,256	
,, tempered......	150,000	
Shear Steel.................	124,400	
Blister ,, ...	133,152	
Mersey Steel and Iron Co. Puddled Steel, highest	173,817	
Ditto, another sample ...	160,832	
Average of three samples tested at the Liverpool Corporation testing machine	112,000	

This steel will also be found most useful for chains and ships' cables, and although the few samples which I have had made all broke at the weld, evidently from want of experience on the part of the smith in working this new material, yet the strains borne at the Liverpool Corporation chain testing machine, even with imperfect welds, are tolerably satisfactory, as will be seen by the following:—

	Tons.	Govt. proof strain. Tons.	Cwt.
Chain $\frac{9}{16}$ in., close link, broke at ...	12 ...	3	15
Chain $\frac{9}{16}$ in., stud link, broke at ...	13 ...	5	10

TABLE D.—TESTS OF STEEL, &c.

BARS 2 INCHES SQUARE, 3 FEET BETWEEN SUPPORTS, WEIGHT IN THE MIDDLE.

	HAMMERED PUDDLED STEEL BAR.				HAMMERED IRON BAR.				ROLLED PUDDLED STEEL BAR.				ROLLED IRON BAR.			
Weight on Centre.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.	Total Deflection.	Additional Deflection.	Permanent Total Set.	Additional Permanent Set.
T. C.																
3 18	·18	Nil	Nil	Nil	·28	Nil	·14	Nil	·56	Nil	·37	Nil	·84	Nil	·65	Nil
4 18	·37	·18	·14	...	1·03	·74	·79	·65	1·12	·56	·84	·46	1·21	·93	·93	·28
5 18	·75	·37	·51	·37	1·45	·42	1·21	·42	1·78	·65	1·5	·65	2·15	·37	1·87	·93
6 18	1·12	·37	·79	·28	2·03	·57	2·25	·9	2·57	·79	2·25	·75	3·56	1·4	3·28	1·4
7 18	1·68	·56	1·31	·51	3·84	1·81	3·6	1·35	3·37	·79	3·0	·75	5·06	1·5	4·68	1·4
8 18	2·15	·46	1·78	·46	4·93	1·09	4·96	1·51	...	...	...	...	6·75	1·68	6·37	1·75
9 18	2·62	·46	2·25	·46	...	...	...	...	...	...	...	...	...	...	...	...
10 18	3·46	·84	3·09	·84	...	...	...	...	...	...	...	...	...	...	...	...
11 18	4·12	·65	3·75	·65	...	...	...	...	...	...	...	...	...	...	...	...
12 18	4·68	·56	4·31	·56	...	...	...	...	...	...	...	...	...	...	...	...

	TOTAL DEFLECTION.				ADDITIONAL DEFLECTION.				PERMANENT TOTAL SET.				ADDITIONAL PERMANENT SET.			
Weight on Centre.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.	Hammered Steel Bar.	Hammered Iron Bar.	Rolled Steel Bar.	Rolled Iron Bar.
T. C.																
3 18	·18	·28	·56	·84	Nil.	Nil.	Nil.	Nil.	Nil.	·14	·37	·65	Nil.	Nil.	Nil.	Nil.
4 18	·37	1·03	1·12	1·21	·18	·74	·56	·93	·14	·79	·84	·93	...	·65	·46	·28
5 18	·75	1·45	1·78	2·15	·37	·42	·65	·37	·51	1·21	1·5	1·87	·37	·42	·65	·93
6 18	1·12	2·03	2·57	3·56	·37	·57	·79	1·4	·79	2·25	2·25	3·28	·28	·9	·75	1·4
7 18	1·68	3·84	3·37	5·06	·56	1·81	·79	1·5	1·31	3·6	3·0	4·68	·51	1·35	·75	1·4
8 18	2·15	4·93	...	6·75	·46	1·09	...	1·68	1·78	4·96	...	6 37	·46	1·51	...	1·75
9 18	2·62	...	...	...	·46	...	...	...	2·25	...	...	...	·46	...	...	...
10 18	3·46	...	...	...	·84	...	...	...	3·09	...	...	...	·84	...	...	...
11 18	4·12	...	...	...	·65	...	...	...	3·75	...	...	...	·65	...	...	...
12 18	4·68	...	...	...	·56	...	...	...	4·31	...	...	...	·56	...	...	...

Table D gives the deflection of hammered and rolled bars of steel and iron with increasing weights.

The samples, as I have since discovered, were of too soft a description, and better results would have been obtained with harder steel, or perhaps the best results might be obtained by a mixture of hard and soft steel, the hard being placed above the neutral axis, the part which is deflected by compression, and the soft, which is deflected by extension, below.

In experimenting upon the strength of this steel, I found the weight requisite to punch steel and iron plates was relatively as follows. The plates were all ¼-inch thick, and the size of the punch ½-inch (circular).

	Tons.	cwt.
Ordinary boiler plates, punched with a pressure of	8	18
Charcoal ,, ,,	8	3
Steel ,, ,,	15	10

In several trials of the tensile strength of steel plates, it was found that the strain required to break a square inch of this steel varied from 44 to 55 tons.

It may perhaps be well to mention also, that there is no difficulty in working this steel, either hot or cold, in any manner in which the best descriptions of iron are worked, and that no particular knowledge or skill is required on the part of the workmen who use it.

These results show the importance of steel as a material for boilers and shipbuilding purposes, as also for girders and bridges, as the economy in the weight of material required is of the greatest importance for these and for many other similar purposes.

In conclusion, I beg to apologise for the very imperfect paper that I have had the honour of laying before you, but I would plead in excuse the very limited time that has elapsed since I first commenced the manufacture of this material, and also that, from the extraordinary and novel nature of this steel, I have been often much perplexed and puzzled, and have had to renew experiments again and again before I could fully comprehend the sometimes apparently contradictory facts which presented themselves, and added to this that it was in the first place necessary to unlearn a good deal of what I had always been accustomed to look up to as the foundation of all knowledge of the iron and steel manufacture, a task much more difficult than the acquisition of any new idea, when the mind is not occupied with preconceived notions and old established prejudices.

In the experiments which I have tried, I have taken every care to be as accurate as possible, and as the trials have gone on, I have had more and more cause to feel confidence in the result obtained, and, had time permitted, I should have been glad to have extended the trials, as the more I investigated the nature of this material the more satisfactory I found it.

I do not for a moment anticipate that steel manufactured by this patent process will supplant the best description of steel, but I feel confident that it must come largely into use for most ordinary purposes, where cast-steel, from its great cost, cannot be used.

Indeed, if I might indulge somewhat in prophecy, I would express my belief that, in a few years, the manufacture of this wrought steel will have become as important a branch of our national industry as that of iron now is.

If the few facts which I have, however imperfectly, placed before this Society, lead to further inquiry by others more competent, and having more leisure to conduct them to a successful issue, I shall be amply repaid for the time and pains that I have bestowed upon the subject.

The following letter has been received by the Secretary:—

Sheffield, Jan. 19th, 1858.

SIR,—I have read Mr. Clay's paper, a proof copy of which you forwarded to me. It is not only of great interest, but highly instructive to all in the present state of the manufacture of steel. When the production of a steel by puddling becomes more developed and improved, it will be applied to many useful manufacturing purposes, as well as to civil engineering.

Mr. Clay describes Mr. Riepe's process, which originated in Westphalia. The idea of manufacturing steel in a puddling furnace emanated from a process long practised in Germany for making natural steel, called "German steel;" and on a close examination, the effect produced upon the pig-iron used will be found to arise from similar causes. In the manufacture of steel by the puddling process, the object is to decarbonise the crude iron acted upon, and this is attained by allowing it to remain for some time in a fluid state, acted upon by the air which passes through the furnace, and assisted by the addition of a silicated oxide of iron, which is largely added to the metal when in fusion. The mass then becomes to some extent decarbonised, but the iron cinder which has been added has induced the production of a silicate of iron, which, however, is decomposed by the addition of a flux, similar to that used by Dr. Schafheutel in his patent process for producing steel-iron; the oxide of manganese which is used then forms a silicate of that metal, whilst the alkaline property of the other ingredients assist in liberating the iron, which has now nearly arrived at a malleable state. The remainder of the process is a carbonising one, and requires much care and experience from the workman. The raw steel so obtained is subject to many imperfections, from the nature of the means taken to produce it, and as such, whilst it is very useful for many purposes where strength is required combined with lightness, yet it has been found unfit for any hardware purposes, excepting the commonest articles. In Germany, the raw steel is doubled and welded many times before it is used for manufacturing purposes, and even then its molecular construction renders it unfit for making a file or cutting tool, whilst, on the other hand, it is well suited for railway tyres, switches, &c.

Metallurgical processes are progressive. Mr. Clay has detailed to us the mode of producing the material, and he has, with his practical ability, carefully examined the changes which the iron undergoes in the furnace. He is aware of the nicety of the operation, and, consequently, the necessity of careful as well as skilled labour to produce a uniform quality. Doubtless he has noticed many imperfections in the process, and a close examination of the steel so produced has shown him that the atomic construction of the metal is far from perfect. I would, therefore, earnestly draw his practical attention to the fact, that the means adopted for carrying out the theory upon which the process is based, may be rendered more perfect. I would ask, is it necessary to add so large a mass of deleterious matter to the fluid metal to obtain a simple decarbonisation? Mr. Blackwell, in his paper on iron, read before the Society in May, 1855, states, "that it appeared desirable to introduce between the blast furnace and the puddling furnace some intermediate process, which, like that of the *mazéage* of France and the continent generally, should sufficiently decarbonise the grey pig iron at small cost in labour and fuel." This desirable object I have attained by subjecting crude iron, from the blast furnace or a cupola, to the action of any chemical re-agent capable of disengaging oxygen during its decomposition,—thus carbonic acid, or carbonic oxide gases, will be produced by the decomposition of the substance, and by the union of the oxygen contained therein with the carbon contained in the fluid iron from which it is eliminated; the gases so produced, being unable to re-enter the metal, either pass off in vapour, or act upon the silicates or other earthy compounds which the crude iron may contain, precipitating the metallic part, and allowing the earthy matter to flow away as slag, containing compara-

tively but a very small per centage of iron. Thus, by adding a chemical re-agent, which by its decomposition will evolve elements capable of combining with the carbon contained in the iron, and of producing carbonic oxide gas, which, acting upon the earthy compounds, and other deleterious matter contained in the iron, causes such deleterious substances to separate from the iron, I obtain very clean, pure, crystalline metal, capable of being manufactured into superior malleable iron.

I would suggest to Mr. Clay whether such a plan of decarbonising the crude iron be not preferable to the one now adopted, and whether such a modification of the manufacture of puddled steel would not prove to be one step towards perfecting the production of so desirable a metal. I produce a few pieces of my refined and purified metal, which is patented, and since the production of such a description of steel will daily become more and more useful for general engineering purposes, I shall, with pleasure, answer any inquiry upon the peculiar process for producing this refined metal.

We are greatly indebted to Mr. Clay for his varied and careful experiments upon the comparative tensile strength of this metal with iron. The extraordinary degree of strength obtained seems a guarantee for its usefulness for railways, steam navigation, and other purposes.

Mr. Clay has confined his paper to the consideration of puddled steel, and as he wishes to avoid all comparison, I will not enter upon any discussion as regards the usefulness of this steel compared with others now produced, yet I cannot agree with the assertion that cast-steel is unfit for ordnance. The observations as regards shrinkage are, generally speaking, correct, but I wish to remark that the crystalline structure of cast-steel becomes very much varied by the different degrees of heat at which it is poured into the mould. A large quantity of cast-steel is made in Sheffield, for the manufacture of rifles in America, and also on the continent. All steel for such purposes must, of course, be hammered, but cast-steel does not require it so much in making ordnance as malleable iron or puddled steel. However carefully iron ordnance may be manufactured, I much fear they will not be found permanently useful or serviceable, because no weld can be made absolutely perfect when two coats of oxide intervene between the solid metal, as in the case of piling the iron or steel used. I think practice would prove that the mass must become gradually weaker with the continued concussion.

As regards the cost of steel, it may, perhaps, not be known to Mr. Clay, that in Sheffield a steel can be manufactured similar to the puddled steel at less cost, and fully equal in quality, if not, in some instances, superior; it is obtained by puddling the refined metal before alluded to, and then converting it, at a cost of 18s. per ton, which being added to the cost of good sound and properly puddled bar, gives the cost of a similar material to the puddled steel which is sold in Sheffield. The difference which exists between these two kinds of rough steel is, that whilst the converted has only absorbed a certain portion of carbon, in the puddled one it is chemically combined; it is this latter quality which renders the German natural steel more useful than the English steel for miners, since it retains its carbon to the last.

As regards cheap steel, the controversy which so lately appeared in our scientific journals, shows that a practical knowledge of the manufacture of steel, and particularly of cast-steel, is extremely limited, and, at the same time, very imperfect. The intelligent steel-maker in Sheffield has long known the use of common materials, and can extract the maximum amount of usefulness from them—he knows that such steel is only fit for certain inferior purposes. If a steel be wanted for a tap, a die, or for a tool to turn a case-hardened roll, his knowledge leads him to select raw materials freed as much as possible from deleterious matter, and he will so manufacture them that the product shall be fitted for its destined object.

I fully concur in Mr. Clay's remark, that puddled steel, if properly and carefully manufactured, will come gradually into use, and prove highly beneficial both to the practical and civil engineer.—I am, &c.,

CHARLES SANDERSON.

DISCUSSION.

Mr. Newton would ask one or two questions of Mr. Clay, first, with reference to the price at which he could produce the puddled steel of the quality similar to the samples on the table. He thought the cost of the steel, as it came from the puddling furnace, of great importance in considering the commercial value of this process. Mr. Clay had briefly alluded in his paper to the manufacture of ordnance from steel and wrought iron; a little more information on that subject would be interesting. He gathered from the paper that the interior of the cannon was to be of hard steel, whilst the exterior was of a softer and more elastic material. He would be glad to hear some further explanation of this. He also wished to hear some explanation with regard to the difference mentioned between the results of Mr. Clay's experiments and those of the Liverpool Corporation, in proving the strength of this material and the strain it would bear in the form of chains and bars, the difference being so great as to call for remarks. He should further like to be informed whether the experiments quoted were made with square bars or round bars with an area equal to the square inch. Mr. Clay had referred—he thought too briefly—to the manufacture of plates from this patent puddled steel. He thought further information on that point desirable. With regard to the views expressed by Mr. Sanderson, in the communication just read, he (Mr. Newton) thought that gentleman must be under some mistake in stating that the cost of the conversion of iron into steel was only 18s. per ton. He was afraid Mr. Sanderson had deceived himself upon that point, but perhaps practical gentlemen he saw present could enlighten them on that matter.

Mr. Vickers (of the firm of Naylor, Vickers and Co.,) stated that he had tried numerous experiments with the puddled steel, and referred to various specimens on the table as examples of the excellence of the material. With regard to the question of cost, he thought Mr. Sanderson had placed it too low. He believed it would be found that the cost of converting iron into steel would range between 22s. and 25s. per ton with all descriptions of iron—English and Swedish. He had not tried Sanderson's refined steel. The puddled steel manufactured by the Lowmoor Company had not come much into use, owing to the high price they had put upon it. Cast-steel made from puddled steel was more malleable than the generality of English iron converted into steel, and was well adapted for shafts, spindles, and other portions of machinery. He had also used it extensively for cast-steel bells.

Mr. Hobbs was desirous of having some information with regard to cost, particularly with reference to the combination of hard and soft metals in ordnance, as described in the paper.

Mr. Bevan regarded cost as an important element in the consideration of this subject. It was desirable that they should know whether this steel could be produced of a tolerably uniform quality, and at a lower price than the ordinary descriptions of steel now in use. As far as he could judge at present, one of the merits of this invention was the cheapness at which the steel could be produced. Mr. Clay had alluded to variations in quality in the same mass, particularly with reference to rails. In rails especially, what they required was a hard steely surface, with a heavy, tough base. He should like to hear whether Mr. Clay, by this invention, could attain that desirable object at something like a moderate cost, as compared with the old system. If that could be

effected, it would lead to the consumption of a vast quantity of this new kind of steel.

Mr. CHARLES MAY regarded this invention as the commencement in this country of the most important movement in the metallurgy of iron that had taken place for many years past. He had had his eyes upon the various improvements introduced into the manufacture of iron, particularly the method introduced by Uchatius. In most of these there seemed to him to be many important practical objections. As to granulating pig iron and melting it in crucibles, it was a "peddling" process, producing a commodity by pounds which was required by tons. One of the most important services that could be rendered to society would be the production of a steel suitable, not so much for the finer description of tools, as for rails and similar purposes, at a cost not much higher than that of the material now employed. If that were done, they might have a really permanent way upon railways, which, at present, did not exist. This process, if brought into general use, would be improved upon as the manufacture proceeded. They must not be discouraged because it was not yet perfect. The great thing was to encourage manufacturers to carry it on. They were aware of the great difficulty of introducing improvements of any kind in iron works. The ironmasters were, for the most part, men of great wealth, and did not care about improvements. If by this process they could get steel rails at 50 per cent. above the cost of the ordinary iron rails, it would be a very great boon. This material might enter into every part of the structure, not only of the permanent way of railways, but also of the entire rolling stock. It would enable them to lighten the rolling stock; and whilst in one direction they increased the resisting power of the permanent way, on the other hand they decreased the force of the destructive effects upon it; he therefore looked hopefully upon this process. It however struck him as an extraordinary thing that fifteen or sixteen shovelfuls of cinder slag should be used to 300lbs. of iron. He had no doubt that experience would lead to a considerable reduction in that quantity. He understood that, in this process, decarbonizing was the principal thing, although the theory had been set up that carbon was not the only important element in the conversion of iron into steel. Mr. May then entered into a brief description of Siemen's furnace for the admission of heated air, the result of the use of which was, as he had been informed, that in a steel furnace upon that principle a ton of metal was melted with a consumption of only 10 cwt. of coke, as against 90 cwt. with the ordinary furnaces, and Mr. Siemens was at present engaged in applying the same principle to puddling furnaces.

Mr. NEWTON believed at present very little had been done with reference to the manufacture of steel rails, to which Mr. May very justly attributed so much importance, but steel points had been somewhat extensively introduced. Hitherto some difficulties had been experienced with regard to steel rails, inasmuch as although the hardened surface was better calculated to resist wear and tear than the ordinary iron rails, yet the brittle character of the steel was found to be an objection. Mr. Sanderson had lately taken out a patent for hardening and tempering rails, whereby the strength was much increased, and he thought this process would tend to effect that which Mr. May considered so desirable, namely, the providing a really permanent way. He, however, was not able to state what would be the advance of price of Sanderson's process of hardening over that of the ordinary rails.

Mr. WILLIAM HAWES would say a word in defence of a very large body of, he believed, intelligent and able men engaged in one of the most important manufactures of this conntry. Mr. May had told them that the ironmasters were slow to adopt improvements, and for that reason he was afraid to entrust any new process of manufacture to them; at the same time Mr. May looked hopefully to patents taken out by persons not belonging to that class. It was dangerous in a Society of this kind to indulge in wholesale condemnation of any class of manufacturers. He believed the iron-masters of this country would be found always ready to adopt any new plan of real practical utility, for their own benefit in the first instance, and afterwards for the benefit of the community.

Mr. KITTOE said, although not practically acquainted with the manufacture of iron, yet he had tried steel of a similar character to this in the construction of the larger description of taps, and he had found that, in many cases, the metal would not harden without splitting. At the same time, he had made tools for turning purposes from this kind of steel with satisfactory results.

Mr. WM. SMITH remarked that, in the tables A and B, he saw nothing to indicate whether the strains applied were per square inch of metal. He should be glad to be informed as to the description of testing machine employed in these experiments. Another material question was, how this metal behaved under the test?

Mr. CLAY said, before replying to the questions that had been asked, he begged to say that he was only interested in this process as any other iron manufacturer might be. The firm with which he was connected merely worked the patent under a license, but, considering it a subject of vast importance to the engineering interests of the country, he had felt it his duty to bring the subject before the public at the earliest possible date, although, perhaps, a little more time would have enabled him to have put the matter forward in a more complete form. In reply to Mr. Sanderson, the manganese, although mentioned in Mr. Riepe's patent, was not an essential element in the manufacture of the steel, nor was the use of it claimed by him. With respect to the large quantity of cinder slag used, it appeared to be absolutely essential to the success of the process, being used to protect the molten crude iron from the action of the atmosphere. The difficulty in welding, that had also been noticed, was not experienced in working this material. He (Mr. Clay) could confirm what had been said as to the suitability of this steel for miners' tools, it having been used in some of the mines of North Wales with great success. With reference to the cost of manufacture, he felt no doubt that this would be materially reduced as experience was gained, but even at the present early stage, he thought that Mr. May's desire to have steel rails costing only 50 per cent. more than iron ones might not be far from being realized, and that ultimately the cost would probably not exceed that of iron by more than 10 or 20 per cent. With regard to ordnance, on which some further information was desired, he wished it to be clearly understood that he anticipated no difficulty in the manufacture of guns, as described in the paper. The facility in welding this material gave the manufacturer the opportunity of placing the different descriptions of steel, whether hard or soft, in the particular positions required. A hard crystalline steel might be used as the first layer, from which the bore would be taken out. The exterior would be of a softer metal, more elastic than the interior portion, and better able to withstand the immense concussion of the discharge. With reference to the difference alluded to in the results shown by the experiments made at the Corporation testing machine, and those in his (Mr. Clay's) own works, this was caused by the difference between the samples of steel employed. It would be observed that the variations were not nearly so great as in the experiments detailed in Mr. Mallet's work. The bars tested were half-inch square, and the results were, of course, calculated from them. The testing machine was a powerful steel yard, which was attached to one end of the bar, the other end being firmly fixed to a strong bed-plate, and the weight gradually increased until fracture ensued. With regard to the rolling of steel plates, many tons had been successfully produced and tested, the average tensile strength being about the same as that of the bars.

They were also remarkable for being very easily worked either hot or cold, and were particularly easily caulked; they were also less liable to corrosion than iron. As to the practicability of making rails with a hard surface and a soft base or centre, it was shown in the paper that this was one of the special advantages of the process. In reply to Mr. Kittoe, it had never been proposed to use this material for such fine purposes as taps and dies, but after having been melted in the usual manner it might be so employed.

Mr. CHARLES MAY remarked with reference to the power required for punching holes in iron plates, that it was laid down by Colthurst, that to punch an inch hole in an inch plate required a pressure of 150,000 lbs. which came so near to the results mentioned by Mr. Clay that he was inclined to place great faith in the other experiments detailed in the paper.

The CHAIRMAN proposed a vote of thanks to Mr. Clay for his valuable paper, and also for the candid and straightforward manner in which he had replied to the numerous questions that had been put to him.

A vote of thanks was passed to Mr. Clay.

The Secretary announced that on Wednesday evening next, the 27th inst., a paper by Mr. J. G. Crace "On the Use of the Soulages Collection of Italian Art in Modern Art Manufacture," would be read. The Manchester Art Treasures Committee have kindly permitted a few specimens of the collection to be exhibited for the purpose of illustrating Mr. Crace's Paper.

The Secretary has received the following letter since the meeting:—

DEAR SIR, — Having duly received your obliging intimation of the subject to be brought before the Society of Arts this evening by Mr. William Clay, I regret that I am not able to attend personally—not that it would be in my power to give any useful information on the practical manufacture of steel, but because I should have much pleasure in confirming the remark made in the paper, to the effect that the experiments made at this factory with what is called "homogeneous metal," have been so satisfactory as to have led to the order for three sets of boilers being made at this factory for vessels in H. M. service. Not only is this metal much stronger than the best iron, but there is reason to expect that it possesses the property of being less corrodible, which is a very important consideration in the matter of marine boilers, and I need scarcely observe that the relation of strength to weight, which this metal possesses in a superior degree, is of great importance in the construction of quick-action machinery, such as is now being introduced in marine engineering. I also beg to add that we have found the working properties of this material to be satisfactory, and readily acquired by workmen conversant with the working of steel.—I am, &c.,

CHAS. ATHERTON.

Woolwich Dockyard, Jan. 20, 1858.

LITERARY AND MECHANICS' INSTITUTIONS OF LANCASHIRE AND CHESHIRE.

The following appears in the last number of the *Institutional Gazette*:—

In issuing the programme of the Public Examination of the Institutional Association for the present year, we would express a hope that it will be found to meet the wishes and answer to the experience of the managers of our Institutes. Our solicitude has been directed to circumscribe in our examinations the largest number, who may be encouraged to venture into the arena.

Every one may not be a Paladin, but no one, however timid, need fear his equals. If a candidate's acquirements may be only just above zero,—or if he be unsuccessful after a trial of his strength, he will at least be better armed for a future tilt. He will be better trained; he will see where he is weak; he will be encouraged; and at a future day, industry and perseverance will make him successful.

Our last public examination was a great triumph,—the number of candidates was quite unhoped for,—and the responses to the Examination Papers reflected the highest credit, not only upon the candidates themselves, but upon those gentlemen who stand at the head of the various Institutions in the Union. If anything could add to the satisfaction of the Central Committee, it is the fact that candidates who won prizes and certificates at our public Examination in Manchester for mathematics, were also victorious at a subsequent public Examination held at Burnley; and had the great honour of receiving from the Lord Bishop of Manchester their rewards for excellence and merit.

This conjunction of success has encouraged the Central Committee to persevere in the continuance of their Examinations; it has confirmed us in our opinion of the excellence and judgment of our staff of Examiners, and has solidified the confidence of the public in the practical value of the labours of all engaged in promoting the efficiency of the Institutions in our Union.

The Central Committee relied upon the good services of the local managers of our Institutions, spread over these two counties; without vigour and interest on their part, little success could be hoped for. The confidence reposed in them by the Central Committee was not misplaced. The Secretaries of Institutions laboured diligently, and their efforts were rewarded, as they deserved to be, by the honourable position attained for the Institutions, by the success of their candidates.

We congratulate the association upon the fact, that we are now *de bon accord* with the Society of Arts; that any diversity of aim or interest should have arisen was, to us, a matter of regret. While we are desirous of welcoming all coadjutors in promoting the interests and elevating the character of Mechanics' and Literary Institutions, we could not permit ourselves to be ignored; nor could we permit, on the other hand, a meretricious fame to divert us from the object we have constantly at heart. There has been no real antagonism between the influential members of the Society of Arts and the Central Committee of the Institutional Association. Our wishes with regard to Institutions have been the same. But it could not be expected that this confederacy of Institutions would yield their local influence, or that the Central Committee should sanction a *coup d'état* which we could see would only tend to enfeebling our efforts, and might ultimately terminate in destroying our Union.

We felt the great responsibility of our position, and we were determined not to sacrifice the interests committed to our sacred keeping.

The Society of Arts, under more able and more friendly influence, invites us to assist in a common work. We gladly do so—we are allies—and the influence of this loyal alliance will be felt throughout our Union. The Central Committee believe that they possess the confidence of the Society of Arts; and this belief is shown by the fact, that the papers for the forthcoming public Examination will be based upon the programme issued by the Society of Arts. This cordiality of spirit, and unity of purpose, will conserve also the interests of candidates intending to present themselves for examination. It will enable our examiners to place before candidates the examination papers issued by the Society of Arts and those issued by the Association at the same instant; upon the same subjects; to be submitted to or supervised by the same Examiners.

The Central Committee feel great pleasure in thus acknowledging the courtesy shown by the Society of Arts, persuaded that no *jalousie du métier* need intervene to prevent common action for a public good. There is no forfeit and no sacrifice.

RESIN OIL FOR BURNING IN LAMPS.

In the manufactories now established for preparing resin oil in various countries, many trials have already been made for preparing it in a state fit for burning in lamps, it being thought that if the resinous parts which prevent its burning in ordinary lamps could be removed, and these lamps could be constructed so as to allow the resin oil to be burnt in them, they would furnish in this way a light of great intensity at a very small expense.

It is stated that the proprietors of a manufactory of resin oil, near Wiesbaden, have at last succeeded, after continued trials, in purifying it, and in constructing ordinary lamps with a never-failing reservoir for the oil. The Argand burner, with a double draft of air, by merely a small alteration, has been rendered available, producing a beautiful white light, which, with a diameter of 1·2 centimetres, is equal to the light of four stearine candles, at $\frac{1}{20}$th of the expense. The light is said to be so intensely bright that it is even painful to the eye.

A resin oil lamp, giving the light of four stearine candles, consumes in one hour $\frac{3}{8}$ths of an ounce of oil; one pound of this costing about 4d., so that the consumption in one hour is about one-tenth of a penny.

A further advantage of the above-mentioned lamp is stated to be its extreme simplicity in construction.

SOUTH KENSINGTON MUSEUM.

During the week ending 16th January, 1858, the visitors have been as follows:—On Monday, Tuesday, and Saturday (free days), 3,289; on Monday, and Tuesday, (free evenings), 3,139. On the three students' days (admission to the public 6d.), 771. One students' evening, Wednesday, 483. Total, 7,682.

Home Correspondence.

ON LOWERING VESSELS, &c., DOWN INCLINES.

SIR,—The following plan, which I propose for enabling ships, &c., to be moved down low inclines, or raised up steep ones, has been specially adapted to the case of the *Leviathan*, but the object has been kept in view of affording hints which may be useful on future occasions, as there appears to be a disposition to adhere to the original plan, as regards the *Leviathan*, and increase the force until it is sufficient to propel the vessel down the ways with a sliding action, notwithstanding the expense and delay which the enormous friction of the method necessitates.

The plan I propose consists in partly substituting a rolling motion for a sliding action, by introducing a large number of cannon balls beneath the cradles, and it would be applied to the *Leviathan* as follows:—

Between every second or third rail of the present ways there would be laid a trough-shaped rail, passing from the upper side of the cradle under the ship to the bottom of the "ways;" the width of the trough would be little more than the size of the shot, which, in the present instance, would be small, say six pounders, and the depth about half the diameter. Plates would be placed above these for the upper side of the balls to roll over, which would extend the width of the cradles. These plates would be 12 inches wide, with a flange along each side of about 1 inch deep, and the inner face would be slightly concave from the sides to the centre, in order to allow for the lower troughs not being accurately parallel with each other all along the ways, and yet give the cradles a tendency to keep the upper plates in the centre of the lower troughs. This would provide for five or six times the error which need exist in the troughs, as they would be laid as nearly parallel with each other as practicable, and it would also allow for the tendency which one end of the vessel has to precede the other, even though it should do so to the extent of 18 feet, as there would still be plenty of room between the balls and the side flanges.

The lower troughs being laid on the cross beams which support the present rails, the upper plates would be introduced above them, leaving a space of about a quarter of an inch between their upper surfaces and the lower surfaces of the present iron cross bars. A ball would then be introduced into the trough, and retained in its place, immediately under the outside cross bar, by a rod passed up the trough from the lower side of the cradle, until a steel wedge had been inserted between the cross bar and the plate, and driven in a little. The next ball would then be passed up the trough and retained under the second cross bar in the same manner, and so on until a ball had been placed under each, when the wedges would all be driven tight.

The balls in the next line of trough would not be placed under the cross bars, but half-way between them; those in the next trough would be placed like the first, and so on alternately throughout the series, in order that when the vessel was in motion, one set of balls should be under the firmest part of the structure, whilst the other set were passing over the less supported part of the troughs, which would then be subjected to deflection.

After all the balls had been introduced, which would amount to 4,500 if placed between every second line of the present rails, the wedges would be driven home until a sufficient portion of the weight was removed from the rubbing surfaces on the rails to the rolling surfaces on the balls, to enable a comparatively small force to drag the vessel down the ways; and in order to ascertain by actual trial when this was accomplished, and the forces properly balanced, the strain would be kept on the vessel whilst the wedges were driven home, and the driving continued until the force applied was sufficient to cause it to move, and then the vessel would be immediately stopped again by clamped blocks, placed 2 or 3 inches below the front of the cradles, which would extend across all the rails, to prevent the possibility of the vessel moving farther than it was intended to do. The men would stand upon the cradles to drive the wedges, so as to be out of danger when the vessel moved over the allotted distance of 2 or 3 inches, after which "jack shores" would be placed against each end of the vessel, to afford security whilst the clamp blocks were removed from the rails, as the shores could be removed without any men being in the course of the vessel when the time had arrived for starting it.

As a matter of precaution, the upper plates would be bolted to the cradles, although they would have little tendency to move by the balls rolling under them, whilst their upper surfaces were restrained by contact with others which must rub and not roll.

In order to keep up the supply of balls, and bring them into action as others rolled out, a self-acting arrangement would be placed on the lower side of the cradles, at the commencement of each upper plate, which would place a ball in the trough, and give it a blow at the same time sufficient to cause it to hold in the entrance, and then the upper plate being a little tapered towards the end, it would cause the ball to be brought under the full pressure as the incline rolled over it. The arrangement would be made to supply the balls at any intervals that might be desired, and communications would be carried up to the deck by which the intervals might be altered, and the resistance of the vessel regulated to some extent whilst it was in motion.

If additional power over the motion were thought worth the expense, the arrangement might include bars for locking any number of the balls in the troughs, and converting the rolling to a sliding action.

At present, a notion seems to prevail that a sliding action is safer for lowering vessels than a rolling motion,

but upon what grounds it is not easy to imagine. It seems to me the safest motion must be that in which all the forces remain as constant and little subject to change as possible, and that this is most easily attained with a rolling motion, because the friction forms so small an item that its irregularity does not prevent the result being calculated and provided for with tolerable certainty, whereas, with a sliding action, the friction forms so large an item, which is subject to change by a difference of smoothness in the surfaces and in the quantity of lubricating matter between them, that it may suddenly require a much larger force to overcome it at one instant than at another, and give rise to starts and stoppages similar to those which have been exhibited in the motion of the *Leviathan*.

All that can therefore be converted from a sliding action to a rolling motion is so much taken from an uncertain method, and added to the side on which the focus can be accurately calculated and balanced.

Another notion seems to prevail that there is less friction between wood sliding on wood than with iron over iron; but some experiments which I have made leave little doubt about there being more friction with wood than with iron under a pressure of 280lbs. to the square inch, which is the pressure of the *Leviathan* on its rubbing surfaces, and that the fact of vessels being launched from low inclines on wooden ways must therefore be attributed to something else. In these launches the surfaces are very extensive, and coated with a thick layer of lubricating matter, so that the vessel is really afloat before it reaches the water, not on a thin fluid it is true, but on a fluid which is sufficiently thick to resist being quickly pressed out from between the surfaces, so as to allow them to come into actual contact, and before this occurs the stern has been lifted up by the water, and the vessel acquired sufficient momentum to enable it to clear the ways. In these launches care is taken to arrange the surfaces, so that the lubricating matter cannot easily escape from between them, but in the *Leviathan* the surfaces have been arranged so that the upper ones act as scrapers to the lower ones, and clear away the lubricating matter as effectually as though they were special contrivances for the purpose.

I am, &c.,
E. T. LOSEBY.

Proceedings of Institutions.

BIRMINGHAM.—On Monday, January 11th, the annual meeting of the subscribers to the Birmingham and Midland Institute met in the Lecture Theatre, Paradise-street. Mr. Arthur Ryland (in the absence of Lord Hatherton, the president) occupied the chair; and there were also present Alderman Manton, Councillors Heaton and Smith, Messrs. Abel Peyton, W. Matthews, junr., Brooke Smith, Blakemore, John Jaffray, H. Wiggin, G. Jabet, F. Osler, Saunders, T. Martineau, R. Wright, S. Barker, G. J. Johnson, R. Peyton, jun., Horton, W. Shakspear, J. S. Dawes, T. W. Williams, Albitès, W. M. Williams, T. P. Salt, Gold, W. R. Lloyd, P. Hollins, T. Kenrick, Hopkins, J. S. Wright, the Rev. C. Clarke, and others. The Chairman, after reading a letter from the President, explaining the cause of his unavoidable absence, said he must congratulate them on meeting in that theatre, built from the designs of Mr. Barry, and from the experience of every lecturer who had been heard in it, fully answering the expectations of the most sanguine amongst them. The working part of the Institution was in an excellent and flourishing condition. It had taken a most proud position—a position which he never expected to see it take—in so short a time. Looking back it seemed but a very limited period since it was projected. When they spoke of raising £10,000 for building, they were greeted with an incredulous smile; when they talked of uniting all classes in an Institute, they got the same smile once more. Yet they had done both these things, and had done them well. Still much remained to be done, and he was confident that what was still to be done would be done with success, because he knew the men who had brought the Institute to what it was, would work it out to a satisfactory conclusion.—Mr. Mathews, the honorary secretary, then read the report. It congratulated the members upon the increasing efficiency of the general and industrial departments, upon the completion of the new lecture theatre, and upon the rapid progress of the remainder of the first portion of the new building. Since the last annual report, 146 new members had joined the Institute, making the total 484. The lectures for the past year were then alluded to, and those for the current year were indicated. The Patent Specification library appeared to have been of considerable utility, 240 persons having consulted it during the past year. The council also acknowledged a donation of fossils from the Museum of Practical Geology. Lord Brougham and Mr. Charles Dickens had been elected honorary members. The proceedings in the Industrial Department had been of considerable importance. A proposition had been made to affiliate the Institute to the University of London, so that students of the Institute passing the requisite examinations might be able to graduate in that University; but, from a variety of reasons, it seemed premature to make the application. A scheme had lately been promulgated by the University of Oxford, and an examination would probably be held in Birmingham at Midsummer next; but as none but youths under eighteen years of age would be permitted to compete, it was feared that not many of the students of the Institute would be able to take advantage of it. The report then proceeded to allude to the Institute's own examinations, and to the prizes given by Lord Hatherton, Mr. John Cornforth, and other members of the council, and referred to the fact that Lord Brougham had presented a copy of his works to be given as prizes in the industrial department. The teachers' board had been requested to report upon the question of certificates and prizes, with the view of fixing some standard for the examinations; and the matter would require careful consideration in connection with the schemes of the Society of Arts and the University of Oxford. The Latin class had been abandoned in consequence of the small number of pupils and the difficulty of securing a regular teacher. On the other hand, a class had been formed for practical chemistry, which supplied a want long felt by chemical students. Although the department was not yet quite self-supporting, its state was on the whole very encouraging, as appeared from the reports of the teachers. Exclusive of the attendances at the penny lectures and the penny arithmetic class, the number of students on the books at the close of the autumn term was 396. More teachers were urgently wanted, and the members could render the Institute no more important service than by giving their assistance in the conduct of the classes. Having alluded to the lectures delivered, the report went on to say that Mr. Williams's classes having suffered from a want of scientific apparatus, the Council purchased from Mr. Addams for £85 a set of apparatus for the illustration of optics and heat. The Board of Trade Department of Science and Art promised to contribute two-fifths of the sum, and the rest was raised by private subscription. The accounts for the past year, which had been made up to the 30th November last, had been duly audited. The financial condition of the general department was very satisfactory. Comparing 1856 with 1857, the receipts from subscriptions had risen from £282 to £433 13s.; and the lecture admissions from £50 8s. to £86 4s. 6d. On the whole the income had exceeded the expenditure by £114 12s. 2d.; but this had to be reduced by £5 3s. 4d., being the excess of expenditure over income in the industrial department. This department has been so nearly

self-supporting that the Council could not but congratulate the members upon the result. The class fees had increased from £183 14s. 4d. in 1856, to £194 1s. 1d. in 1857. The amount received from the penny lectures had somewhat fallen off. The Council regretted that the position of the building fund was not equally favourable. The total amount of new donations received in 1857 was £641 3s. 6d., including £100 from Prince Albert, a second donation from the president, Lord Hatherton, and £61 6s. 4d., which was kindly presented by some gentlemen connected with the proprietary school, being the proceeds of a ball held for the benefit of the Institute. A considerable sum had also been obtained by the zealous labours of several gentlemen in canvassing some of the wards of Birmingham. The amount already expended upon the building, in the cost of the Act of Parliament, in the purchase of the outstanding interests in the property conveyed by the Town Council, and in preliminary and other expenses, was £11,241 1s. 7d. To meet the amount which would become due upon engagements already entered into, and to provide furniture and fittings, it would be necessary to raise a further sum of at least £5,000. The meeting was afterwards addressed by Mr. Brooke Smith, Mr. J. S. Wright, Mr. Langford, Mr. W. M. Williams, and Mr. Kenrick. Alderman Manton moved a vote of thanks to the President and Council, which was seconded by Mr. Heaton, and passed amidst applause. On the motion of Mr. T. Martineau, seconded by Mr. W. R. Lloyd, thanks were voted to the teachers.—The Chairman said it might be interesting to state that the aggregate attendance at the classes was 2,250, and at the penny lectures 7,218. He thought that the want of systematic attention to the classes was the rock on which such Institutions generally split.—Mr. Smith then moved that Lord Ward be requested to accept the office of President for the year, which was seconded by Mr. T. Williams, and agreed to.—Mr. P. Hollins suggested that although the scruples of Mr. Ryland to continue in office were very great, he hoped the meeting would overcome them. He therefore moved that Mr. Ryland and J. B. Hebbert be appointed vice-presidents.—Mr. H. Wiggin seconded the resolution, remarking that if it had not been for the exertions of Mr. Ryland, the building would not have been in existence. The motion having been agreed to, the election of other officers took place, and the meeting separated.

MEETINGS FOR THE ENSUING WEEK.

MON. Actuaries, 7.
Architects, 8.
Entomological, 8. Anniversary.
Geographical, 8½. I. Reports on the Expedition up the Niger, by Dr. Baikie, R.N., and Mr. May, R.N. II. Further particulars of the progress of the British North American Exploring Expedition, as far west as long. 109° on the Lower Saskatchewan, by Captain Palliser. III. Journey from Little Namaqualand eastward along the Orange River, the Northern Frontier of the Colony, &c., with Map, by Mr. Robert Moffat.

TUES. Royal Inst., 3. Prof. Huxley, "On Vegetable Life."
Meteorological, 7.
Civil Engineers, 8. Mr. T. S. Sawyer, "On Self-Acting Tools for the Manufacture of Engines and Boilers."
Med. and Chirurg., 8½.
Zoological, 9.

WED. Society of Arts, 8. Mr. J. G. Crace, "On the Use of the Soulages Collection of Italian Art in modern Art Manufacture."
Archæological Asso., 8½.

THURS. Royal Inst., 3. Prof. Tyndall, "On Heat."
Royal Society Club, 6.
Numismatic, 7.
Antiquaries, 8.
Royal, 8½.

FRI. Royal Inst., 8½. Mr. W. R. Grove, "On Molecular Impressions by Light and Electricity."

SAT. Royal Inst., 3. Mr. C. R. Bloxam, "Chemistry of the Elements."
Medical, 8.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, Jan.* 15, 1858.]

Dated 18th September, 1857.

2428. George Edward Dering, Lockleys, Hertford—Improvements in laying down electric telegraph cables, in obtaining soundings, and in ascertaining the position of and raising submerged electric telegraph cables and other bodies.

Dated 30th November, 1857.

2980. Jean Baptiste Couy, Nantes—Improvements in the manufacture of manure, and, for the disinfection of animal and vegetable matters.

Dated 9th December, 1857.

3045. Charles Westendarp, jun., Mincing lane—Preparing a material as a substitute for ivory, which he proposes calling "artificial ivory."

Dated 17th December, 1857.

3095. Montague John Turner and Marcus William Turner, Woodcote, Surrey—The improvem nt of conduit pipes and tubes for sewers, drains, conduits, gas, and other purposes.
3096. Francis Mollett Blyth, Norwich—Improved apparatus for cutting and pulping turnips and other roots.
3097. William Blizzard, 14, Victoria-terrace, Notting-hill—Improvements in the treatment of india rubber by a new process for the manufacture of a chrystalline and colourless varnish for waterproofing all kinds of textile fabrics and papers, without smell and without in any degree altering their appearance, and for making divers varnishes and paints.
3099. Mark Mason, Dukinfield, Chester, and Thomas Markland, Newton, near Hyde—Improvements in machinery or apparatus for printing.
3101. Edward Highton, Regent's-park—Improvements in electric telegraphs.
3105. John Henry Johnson, 47, Lincoln's-inn fields—Improvements in lubricating the journals of shafts and spindles. (A communication.)

Dated 18th December, 1857.

3107. Joseph Bennett Howell and John Shortridge, Sheffield—An improved mode of rolling steel for springs.
3109. David Bowlas, Reddish, Lancashire—Improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances.
3113. James Murdoch Napier, York-road, Lambeth—Improvements in letter-press printing machines.

Dated 19th December, 1857.

3115. Thomas Newey, John Corbett, and William Henry Parkes, Birmingham—A new or improved method of treating or coating steel pens and pen holders, to prevent the oxidation of the same, which method of treating or coating may also be applied to other articles of iron and steel.
3119. William Walker, Leeds—An improved apparatus for the purposes of heating and drying.
3121. Richard Archibald Brooman, 166, Fleet-street—Improvements in lime kilns, and in apparatuses employed for working the same. (A communication.)
3123. Thomas Coles, Bristol—An improvement in chaff cutters.
3124. William Bough, 1, Jewin crescent, Cripplegate—Improvements in lamps and wicks for burning resin and other oils and fluids, parts of which improvements are applicable to Argand gas burners.
3125. Robert Mushet, Coleford, Gloucester—Improvements in the manufacture of iron.

Dated 21st December, 1857.

3129. William John Kendall, Norwich—An improved safety signal for railways.
3131. Francis Taylor, Romsey—Improvements in closets or privies.
3132. George Tomlinson Bousfield, Loughboro'-park, Brixton—Improvements in machinery used in the manufacture of springs, and in the application of springs to carriages. (A communication.)
3133. William Henry Myers, 202, Whitechapel-road—An improved coffee pot, made of metal or earthenware, to contain coffee and milk or cream separately, the same being used as a chocolate pot, the same invention being applicable to teapots for the same purposes, made either in metal or earthenware, the same invention being applicable to table urns, and the same invention being applicable to jugs, made either in earthenware, or glass, or metal, to contain spirits and water or other liquids in different compartments.
3135. Richard Archibald Brooman, 166, Fleet-street—Improvements in breech-loading fire-arms. (A communication.)
3137. Alphonse René le Mire de Normandy, Judd-street, Brunswick-square—Improvements in apparatus used for distilling sea water on board ships and vessels.

Dated 22nd December, 1857.

3139. Arthur Challis Kennard, Falkirk Iron Works, Stirling, N.B.—Improvements in trussed iron bridges. (A communication.)
3141. John Henry Johnson, 47, Lincoln's-inn-fields—An improved signal apparatus to be attached to common road carriages. (A communication.)
2143. Orlando Greenhalgh, and Robert Hutchinson, Horwich, Lancashire—Improvements in apparatus for stirring and mixing colours for calico printing and other purposes.

3145. George Bridge, Bollington, near Macclesfield, and Job Hamer, Longsight, near Manchester—A new process or manufacture for converting woven silken fabrics or silk waste into a fibrous material fit for being spun into yarn or thread, or for being mixed with silk, woollen, cotton, or any other material to be spun into yarn or thread, and of improvements in machinery to be employed in such process or manufacture.

Dated 23rd November, 1857.

3146. Daniel Jones Crossley, Hebden Bridge, Yorkshire—Improvements in the manufacture of certain textile fabrics, called Pellones, and used for saddle covers, and in the machinery or apparatus employed therein, which improvements are also applicable for weaving other fabrics.

3147. Thomas Landi, 16, Rue de Boulevard, Batignoles, Paris, and Charles Falconieri, 20, Charles-street, Middlesex Hospital, London—Improvements for laying subaqueous electrical cables for telegraphic communications.

3149. Christopher Nugent Nixon, Ramsgate—Improvements in attaching, fitting, and securing the rudders of ships, barges, boats, and every other description of sailing or steam vessel.

3151. Joshua Moss, Thomas Gamble, and Joseph Gamble, Sheffield —An improvement in the manufacture of cast steel hoops and cylinders.

3153. Charles Norton, 3, Lancaster-place, Camden-street, Camden-town—Carriage door shields to prevent accidents arising from the shutting of railway or other carriage doors, also applicable for nursery doors, or any other doors where children may have access, or where safety from accident may be an object.

Dated 24th December, 1857.

3155. George White, 5, Lawrence Pountney-lane, Cannon-street—A semi-melodion or instrument for demonstrating musical writing. (A communication).

3156. Charles Reeves, Birmingham—Improvements in repeating or revolving fire arms.

3157. Samuel Henry Adderley, of Birmingham—Improvements in the manufacture and ornamentation of pencil cases, pen-holders, reserves or cases for leads, needle cases, and ink-holders and other tubular cases.

3158. Thomas Playle, Chatham—Improvements in two-wheeled carriages.

3159. George Croft, Leeas-street, Keighley, and Smith David Steel, Greengate Mills, Keighley, Yorkshire—Improvements in machinery or apparatus for combing and preparing wool and other fibrous substances.

3161. George Burley, King's-cross-road, near Halifax—Improvements in apparatus for cutting the pile of fustians and other pile fabrics.

3162. Henry Charles Fenwick Wilson and Thomas Green, Dunston —A machine or apparatus for making rivets.

3163. Henry Charles Fenwick Wilson and Thomas Green, Dunston —Improved machinery or apparatus for making rivets.

3164. Benjamin Burleigh, 26, Great George-street, Westminster, and Frederick Ludwig Danchell, 452, Oxford-street—Certain improvements in the manufacture of vessels, plates, or utensils, used for domestic, sanitory, electric, and manufacturing purposes.

Dated 26th December, 1857.

3165. Alexander Chaplin, Glasgow—Improvements in steam engines, and in the combustion of fuel.

3166. Antonio Ribeiro Saraiva, Nottingham-street, Marylebone—An improved candlestick or holder.

3167. Charles Frederick Parsons, 1, Duke-street, Long-alley, Finsbury—Cleansing and reburning animal charcoal.

Dated 28th December, 1857.

3168. Alexander Bruce, Manchester—Improvements in watches and time pieces.

3169. John Barling, Halifax—An Improved paddle for propulsion on water.

3170. John Henry Johnson, 47, Lincoln's-inn-fields—Improvements in the treatment and preservation of skins, furs, wool, and textile fabrics, and in the machinery or apparatus employed therein. (A communication).

3171. H. Deacon, Widnes—Improvements in purifying alkaline lees.

3172. James Boydell, 65, Gloucester-crescent, Camden-town—Improvements in carriages propelled by steam or other power.

3173. James Wadsworth, Hazelgrove, near Stockport—Improvements in the production and management of artificial light, and in apparatus applicable thereto.

3176. John Thomas Griffiths, New Basford, Nottingham—Improvements in the manufacture and ornamenting of lace.

3177. Isaac Holden, St. Denis, near Paris—Improvements in preparing and combing wool and other fibres.

Dated 29th December, 1857.

3178. Thomas Spencer, 192, Euston-road—Improvements in the purification of illuminating or lighting gas.

3179. Henry Thompson, Liverpool—Improvements in the application or use of a certain substance as a substitute for glue, paste, cement, varnish, and other similar compounds.

3180. John Hargreaves and Joseph Hargreaves, Liverpool—Improvements in winding up watches which have not fusees or chains.

3181. Alexander Parkes, Birmingham—Improvements in joining or uniting metals.

3182. Victor Mourot, 43, Rue de Paradis Poissonnière, Paris—Improvements in furnaces for heating kilns and ovens used in the manufacture of pottery and earthenware, part of which improvements are also applicable to furnaces generally.

3183. Edwin Gomez and William Mills, New York, U.S.—An improved composition for trains or safety fusees, and similar purposes.

Dated 30th December, 1857.

3185. Frederick Oldfield Ward, 12, Cork-street, Burlington-gardens —Improvements in liberating or producing potash or soda, or both (as the case may be), from natural alcaliferous silicates, the residuum of the process being available as a material for manure, puzzolano, or hydraulic cement. (Partly a communication.)

3186. William Henry Tooth, 9, Sumner-street, Southwark—Improvements in furnaces.

3187. Francis Palling, 134, Princes-road, Surrey—The construction of candles, lamps, and candle-lamps, without wicks.

3188. Tempest Booth, Manchester—Improvements in the treatment of certain vegetable matters, and in the application of the same to sizeing, stiffening, dressing, and finishing textile materials, and which is also applicable to thickening colours for printing.

3189. James Darsie Morrison, Edinburgh—Improvements in effecting surgical and medical operations by the agency of artificially induced anæsthesia.

3190. John O'Neill, Liverpool—Improvements in apparatus for communicating betwixt the guard or passengers and the engine-driver on railway trains.

3191. Alfred Vincent Newton, 66, Chancery-lane—Improved machinery for cutting corks and bungs. (A communication.)

3193. Richard Harmer, Union-street, Spitalfields—Improvements in cigarettes.

Dated 31st December, 1857.

3194. Carl Buhring, 91, Pratt-street, Camden-town—Improvements in the combination of carbonized and carbonizable with other materials, and the manufacture of such compounds into various useful articles.

3195. Henry Hanson, Stockport—Improvements in the manufacture and finish of cotton-band, twine, rope, cordage, and other fibrous substances, and in machinery or apparatus employed therein.

3196. Peter William Barlow, 26, Great George-street, Westminster—Improvements in the permanent way of railways.

3197. Augustin Julien Michel Ramar, 49, Broad-street, Golden-square—Improvements in ornamental and portable fountains.

3198. George Wilson, Sheffield—Improvements in the furnaces or fire-places of steam boilers. (A communication.)

3199. William Middleship, Grove-terrace, South-grove, Mile-end—Improved machinery or apparatus for obtaining motive power.

3200. James Long, Gorleston, Yarmouth, Norfolk—Improvements in the construction of sewers, and in the means of discharging the contents thereof.

Dated 1st January, 1858.

1. John Henry, Friday-street—Improvements in weaving fabrics for ladies' dresses and petticoats.
3. Louis Joseph Arséné Brun, Paris—Improvements in instruments for measuring angles, applicable to nautical and other purposes.
4. George Gorle, Handsworth—A new or improved service-box for water-closets.
5. Alexander Parkes and Henry Parkes, Birmingham—Improvements in the manufacture of rods, wire, nails, and tubes.
6. John William Clare, Surrey-square—Improvements in steam-engines and boilers, part of which improvements is applicable to furnaces.
7. John Henry Johnson, 47, Lincoln's-inn-fields—Improvements in penholders, pencil cases, and other articles sliding in cases of a like nature. (A communication.)

Dated 2nd January, 1858.

8. Robert Harvey, Glasgow—Improvements in steam hammers.
9. Archibald Slate, Adelaide-road, Haverstock-hill—Improvements in apparatus for supplying fuel to blast furnaces.

INVENTION WITH COMPLETE SPECIFICATION FILED.

Dated 1st January, 1858.

2. James Murphy, Newport, Monmouthshire—Improvements in wheels used on railways.

WEEKLY LIST OF PATENTS SEALED.

January 15th.

1996. Richard Bolton.
2041. Nicolas Saintaird.
2165. Paul Emile Laviron.
2253. Alfred Vincent Newton.
2317. William Edward Newton.
2324. William Edward Newton.
2680. Robert Atkinson and Thos. Brearey.
2923. Thomas Glover and Alexander Bain.

January 19th.

2025. W. Hudson and C. Catlow.
2027. Charles Norris.
2029. James Burrows.
2035. F. Oetzmann & T.L. Plumb.
2161. William Edward Newton.
5383. Alexander Gray.
2507. William Edward Newton.
2593. William Edward Newton.
2819. Henry Bessemer.
2849. Edward Halliday Ashcroft.
2945. Antoine and Jean Martin.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

January 12th.

85. Christopher Turner.
95. Gustav Warnecke.
231. Henry Davis Pochin.

January 13th.

114. James Lee Norton.

January 14th.

106. George Riley.
115. Jonathan Saunders.
116. Jean Antoine F. V. Oudin.

January 16th.

129. Constant Jouffroy Dumery.